



## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification<sup>6</sup>:

H01R 4/50, 4/44

A1

(11) International Publication Number:

WO 98/59393

(43) International Publication Date: 30 December 1998 (30.12.98)

(21) International Application Number: PCT/US97/11055

(22) International Filing Date: 24 June 1997 (24.06.97)

(71) Applicant (for all designated States except US): THE WHITAKER CORPORATION [US/US]; Suite 450, 4550 New Linden Hill Road, Wilmington, DE 19808 (US).

(72) Inventors; and

(75) Inventors/Applicants (for US only): NGO, Hung, Viet [US/US]; 4415 St. Andrews Way, Harrisburg, PA 17112 (US). GARVER, William, Joseph [US/US]; 1012 Topview Road, Harrisburg, PA 17112 (US).

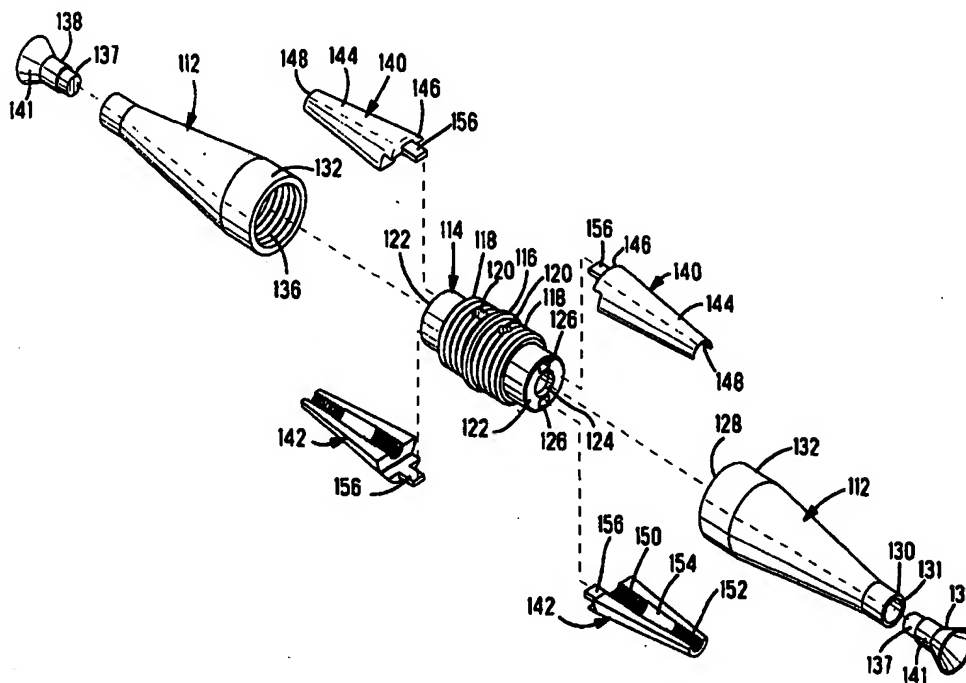
(74) Agents: VANATTEN, Mary, K. et al.; The Whitaker Corporation, Suite 450, 4550 New Linden Hill Road, Wilmington, DE 19808 (US).

(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TR, TT, UA, UG, US, UZ, VN, ARIPO patent (GH, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published

With international search report.

(54) Title: MECHANICAL CONNECTOR SPLICE FOR CABLE



(57) Abstract

The invention is directed to an electrical connector (10, 110) for mechanically and electrically connecting two conductors together. The connector has a housing with a moveable jaw (14, 140). The jaw (14, 140) has two gripping surfaces (48, 50, 150a, 152a) for engaging the conductors. One of the gripping surfaces (48, 105a) is disposed in a different plane than the other of the gripping surfaces (50, 152a) thereby defining a circuitous path for receiving the conductor therein.

**FOR THE PURPOSES OF INFORMATION ONLY**

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece			TR	Turkey
BG	Bulgaria	HU	Hungary	ML	Mali	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MN	Mongolia	UA	Ukraine
BR	Brazil	IL	Israel	MR	Mauritania	UG	Uganda
BY	Belarus	IS	Iceland	MW	Malawi	US	United States of America
CA	Canada	IT	Italy	MX	Mexico	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NE	Niger	VN	Viet Nam
CG	Congo	KE	Kenya	NL	Netherlands	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NO	Norway	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	NZ	New Zealand		
CM	Cameroon			PL	Poland		
CN	China	KR	Republic of Korea	PT	Portugal		
CU	Cuba	KZ	Kazakstan	RO	Romania		
CZ	Czech Republic	LC	Saint Lucia	RU	Russian Federation		
DE	Germany	LI	Liechtenstein	SD	Sudan		
DK	Denmark	LK	Sri Lanka	SE	Sweden		
EE	Estonia	LR	Liberia	SG	Singapore		

## MECHANICAL CONNECTOR SPLICE FOR CABLE

The present invention is directed to a mechanical connector for splicing a pair of cables of the type used in electrical utility style overhead distribution and transmission systems.

Overhead distribution of electrical cables typically are a part of the distribution portion of the power network. The cables are designated AAC, AAAC, or ACSR which stand for all aluminum conductor, all aluminum alloy conductor, or aluminum conductor steel reinforced, respectively; or they may be copper where cable diameters are in the range of three quarters to one inch. Transmission cables are typically stranded aluminum conductors about a steel reinforcing core (ACSR) having a diameter from three quarters of an inch and up.

There are a number of patents directed to splicing transmission type cable where the inventions rely upon devices which are activated in the same direction as the cable and have cable gripping jaws which grip on the cable in the direction of the tension of the cable. Many of these inventions are terminated by using internally fired or explosively activated devices or, alternatively, tool activated devices, or spring activated devices where either the explosive force, the tool activation, or the spring pushes a set of jaws outwardly thereby having them clamp down and around the cables to be connected.

U.S. Patent No. 3,515,794 shows such an electrical connector which is tool activated. The connector has a hollow shell with a tapered internal surface. Along the internal surface of the hollow shell are a plurality of conductor gripping jaws which are compressible on the conductor at spaced locations along the internal surface. The connector is applied by use of a tool

which forces the jaws of the connector along the tapered internal surface to compress the gripping jaws on the conductor.

5 In order to maintain a good electrical and mechanical grip on the conductors, it is necessary to provide tension along the conductors to keep the gripping jaws on the conductor at a location where they provide a good grasp on the conductor. In order to maintain this tension, it is necessary that both  
10 conductors are terminated within the electrical connector at the same time thereby ensuring that the force from the gripping jaws is maintained on the conductors.

15 In order to allow good electrical flow, contact interfaces must be obtained between several components of the connector, between the conductor and the gripping members, between the gripping members and the hollow shell, from the hollow shell to the other half of the connector and its components.

20 What is needed is an electrical connector that will provide a good gripping force on the conductors but will be able to be terminated to only one conductor at a time and still provide a good gripping action. What is also needed is an electrical connector with fewer contact  
25 interfaces to ensure low impedance to the electrical flow.

The invention is directed to an electrical connector for mechanically and electrically connecting two conductors together. The connector has a housing  
30 with a moveable jaw. The jaw has two gripping surfaces for engaging the conductors. One of the gripping surfaces is disposed in a different plane than the other of the gripping surfaces thereby defining a circuitous path for receiving the conductor therein.

Embodiments of the present invention will now be described with reference to the accompanying drawings, in which:

Figure 1 is an isometric view of the electrical connector of the current invention showing the gripping jaws exploded away from the housing;

Figure 2 is an exploded cross sectional view of the electrical connector of the present invention;

Figure 3 is a cross sectional view of the electrical connector of the present invention showing the conductors spliced and terminated to the electrical connector;

Figure 4 is an isometric view of the assembled connector of the present invention;

Figure 5 is an exploded isometric view of the connector;

Figure 6 is a cross-sectional view showing an unterminated connector;

Figure 7 is a cross-sectional view showing the connector terminated;

Figure 8 is an enlarged view similar to Figure 6;

Figure 9 is an enlarged view similar to Figure 7 and

Figure 10 is an exploded cross-sectional view of the connector.

Figure 1 shows a first embodiment of the electrical connector 10 of the present invention. The electrical connector 10 includes a main housing 12 and two gripping members 14. The main housing 12 is preferably made from an electrically conductive material such as aluminum, copper or alloys thereof. The main housing 12 receives the electrical conductors C therein. The gripping members 14 are received on the main housing 12 and are used to secure the conductor therein. The gripping members 14 can be made from an electrically conductive material, or it can alternatively be made from some

other material with enough strength to engage the conductors C and prevent pull outs from the connector 10.

5 The main housing 12 has a conductor receiving passageway 20 which extends through the main housing from one end to the other and has two openings 22 disposed at either end of the passageway 20. The openings 22 are shown in Figure 1 as uncovered openings, however, it is possible that a cap or some other type of  
10 insertion member can be received within the openings 22 to provide both protection for the interior of the main housing and the conductor receiving passageway. It is also possible to provide an insertion assistant device for assisting in guiding the conductor C into the  
15 conductor receiving passageway 20.

The main housing 12 has a flat top 24 extending along the entire length of the main housing 12. Extending from the flat top into the interior of the main housing 12 are jaw openings 26. The embodiment as  
20 shown in Figure 1 has four jaw openings received along the flat top 24. The jaw openings 26 extend from the flat top 24 through to the conductor receiving passageway 20 as is shown in Figure 2. There are also four screw holes 28 received along the flat top 24. The  
25 screw holes are shown in Figure 2 as being received completely through from the flat top 24 to the conductor receiving passageway 20, however, it is not necessary that they extend completely through to the conductor receiving passageway. It is only necessary that the  
30 screw holes 28 extend sufficiently far enough into the main housing 12 so that screws 30 can be received therein to secure the gripping members 14 to the main housing 12.

The conductor receiving passageway 20 has a top 32  
35 and a bottom surface 34. The bottom surface 34 is shown having a rough surface 35 such as a threaded surface.

Alternatively, the rough surface could be just parallel serrations, grooves, or a rough textured surface providing an interface that will provide a sufficient contact with the conductor C. Preferably, the threaded  
5 surface will have grooves that run perpendicular to the direction of the conductor C to provide better gripping action on the conductor.

Along the center of the conductor receiving passageway 20 is a separating wall 40 which separates  
10 the passageway into individual halves for receiving the different conductors C. Along each one of the halves of the conductor receiving passageway 20 there are two separate conductor receiving levels 36,38. Conductor receiving level 36 is closer to the opening 22 and is  
15 positioned higher than the conductor receiving level 38. The importance of this feature will be described more fully hereinafter.

Each of the gripping members 14 have two gripping jaws 50 which extend from a bottom surface of the  
20 gripping member. The gripping member 14 also has a top rounded surface 54 with two screw receiving holes 56. The screw receiving holes 56 are surrounded by recesses 57 which are set back from the top rounded surface 54. The recesses 57 are designed to receive the screw head  
25 therein so that the screw head is not protruding along the top surface of the gripping member 14. The screw holes 56 are non-threaded holes and are designed to receive the threaded portion of the screw therethrough without threadingly engaging the screw hole. The screw  
30 head abuts against a bottom wall of the recess when the gripping member 14 is secured to the main housing 12.

Each of the gripping jaws 50 also have a serrated section 58. The serrated section as with the earlier described serrated section can either be a machine screw  
35 section or, alternatively, parallel serrations, grooves, or a rough textured surface to provide an interface

sufficient to grip on the conductor C and provide a good electrical and mechanical connection therebetween.

Figure 3 shows the assembled electrical connector on the conductors C. The conductors C are received  
5 within the conductor receiving passageway 20, each extending from one of the respective openings 22. The conductor C is received within the connector receiving opening 20 until the end of the conductor abuts against the separating wall 40 thereby ensuring that the  
10 conductor is received far enough within the conductor receiving passageway to get proper termination with the gripping jaws 48,50. Figure 3 shows two conductors C received within the electrical connector, however, it is not necessary that both be terminated at the same time.  
15 One of the conductors C can be terminated without it being necessary to terminate the other conductor.

Once the conductor C is received within the connector receiving passageway, the crimping member 14 is secured to the top of the main housing 12 by  
20 inserting the screws 30 through the screw receiving holes 56 and into the screw holes 28. The screws threadably engage the screw holes 28 to secure the gripping member 14 to a main housing 12. The screws can be of the locking type wherein one section preferably a  
25 middle section of the screw, is thicker than the beginning section of the screw, so that as the screw is being secured within the screw hole 28, it will engage the screw hole 28 more snugly and thereby preventing the screw from backing out due to vibration or other means.

30 When the gripping member 14 is being secured to the main housing, the gripping jaws 48,50 are pushed through the openings 26 and into the conductor receiving passageway 20. The serrated sections 58 on the gripping jaws 48,50 are received against the conductor C and as  
35 the screw is turned, the head of the screw engages the recess 57 causing the gripping member to be pushed down



against the conductor and forces the serrated section to bite into the surface of the conductor thereby forming a good electrical and mechanical connection therebetween. Also, because of the force, the serrated section along the bottom surface 34 of the conductor receiving passageway will bite into the surface of the conductor C thereby forming a good electrical and mechanical connection therebetween.

The good gripping action is obtained by the different conductor receiving levels 36,38 within the conductor receiving passageway working in conjunction with the different size gripping jaws 48,50. The longer gripping jaw 48 corresponds with the lower conductor receiving level 38 whereby the conductor C is pushed further down in this area because the conductor is pushed into different levels through the conductor receiving passageway. In the section between the gripping jaws 48,50 the conductor C will get squeezed more into the area between the two gripping jaws 48,50. The conductor will be deformed this way because the creep of the aluminum of the conductor. When the aluminum is placed under pressure, it will tend to flare or flow out of the area of pressure. Therefore, material from the conductor will flow into the area between the gripping jaws. Because conductor C is being deformed in this way such that it is squeezed into this area, it makes it more difficult for the conductor to be pulled back out of the electrical connection connector. The deformed material of the conductor will engage against the higher level 36 and against the gripping jaw 50 to prevent the conductor from being pulled out laterally from the terminated connector.

Both of the conductors C are pushed against the serrated section along the bottom surface 34 of the conductor receiving passageway thereby providing good electrical connection from the conductors C to the main

housing 12. Therefore, there are only the contact interfaces between the two conductors C and the main body which must be made in order to ensure good electrical flow and only one member external to the conductors through which electricity must flow.

The first embodiment presented in the drawings is shown with symmetrical halves to the electrical connector to receive conductors of approximately the same diameter. It is also possible that the electrical connector can be designed to receive different sized conductors. In order to do this, it would be necessary to design the halves so that one side is smaller or larger than the other to accommodate the different sizes.

The advantages of the first embodiment of the invention are that there is only one surface which must be formed between the electrical conductor C and the connector to provide a good electrical connection therebetween. Further, the use of gripping jaws at different levels provides a good mechanical connection to the conductor C preventing pull out of the conductor.

Figure 4 shows a second embodiment of the present invention. The electrical connector 110 includes two conical end sections 112 and a middle connection section 114, see Figures 4 and 10. The connecting section 114 includes a central rib 116 and threaded portions 118 along either side of the central rib 116. Extending through each of the threaded portions 118 are tool holes 120, the purpose of which will be described more fully hereinafter. The connecting section 114 has two ends 122. Each of the ends has a cable receiving hole 124. On two sides of the hole 124 are tab slots 126.

The conical end sections 112 each have two ends 128, 130. End 128 has a large opening to engage the connecting section and an end 130 has a small opening 131 to receive the cable therein. Along end 128, the

conical end sections 112 have outer, smooth, cylindrical gripping surfaces 132 for terminating and unterminating the connector. Alternatively, the gripping surfaces could be hexagonal, octagonal, or some other angled flat surfaces, shaped so that the conical end sections can be gripped with a tool. The conical end sections 112 are sloped inwardly from end 128 to end 130.

The conical end sections 112 have hollow interiors with sloped walls 134, see Figures 6 and 10. Along end 118, on the interior of the conical end sections 112 are threaded portions 136, see Figure 5 and 6.

Received within the small openings 131 are end caps 138. These end caps 138 are used to keep the antioxidant gel within the interior of the conical end sections 112 until a cable is inserted therein. The end caps 138 are made of a lead-in part 141 and a soft, breakable part 137. The lead-in part 141 of the end caps 138 also provides for wire insertion in that the chamfered surfaces of the lead-in part 141 provide a guide for the cable into the end of the connector 110. When inserted, the cable breaks through the soft, breakable part 137 of the end cap 138 to provide access to the interior. When a cable is inserted into the end of the connector, the breakable part 137 is broken off onto the end of the cable C. The breakable part 137 acts as a guide to help the cable move into the connector by keeping the end of the cable from fraying or stubbing on parts of the connector during insertion of the cable.

The electrical connector has a total of four jaws 140, 142, two jaws are received within each of the conical end sections 112. Each of the jaws have an outer, conical shaped surface 144 which is tapered from one end 146 to the other end 148. Each jaw 140, 142 has two gripping surfaces 150, 152 and a sloped surface 154 therebetween. The gripping surfaces and the sloped

surface are disposed along a half-conical shaped channel, which, when two jaws 140, 142 are brought together form a cable receiving channel. Along end 146, each jaw 140, 142 has a tab 156.

5       The electrical connector 110 is assembled as is shown in Figure 6. The jaws 140, 142 are aligned with the connecting section 114 by inserting the tab 156 into the tab slots 126. The conical end section 112 is then secured to the connecting section 114 over the jaws 140,  
10       142. The conical end section 112 is secured to the connecting section 114 by engagement of the threaded portion 118 with the threaded portion 136. The other side of the electrical connector 110 can be assembled in a similar manner. The conical end sections 112 are  
15       screwed on only enough to be secured to the connecting section 114. The tool holes 120 are left exposed. In this position, the jaws 140, 142 are not pressed together and they have room to be pushed apart to receive a cable therebetween.

20       The cables C are then inserted from either end of the electrical connector, as is shown in Figure 7. It is possible for the connector 110 to be connected to one cable at a time. The cable C is pushed through the end cap 138, in between the jaws 140, 142, and is pushed in  
25       until the end of the cable and the breakable part 137 of the end cap 138 are received within the cable receiving hole 124 and abut against the connecting section 114. A tool, such as a screw driver or some other leveraging device, is inserted through the tool hole 120 on the  
30       opposite side of the connector from the side in which the cable has been inserted. The conical end section 112 is then screwed down by engaging the gripping surface 132, using the tool as a lever, and turning the conical end section 112 until the end 128 of the conical  
35       end section 112 engages the central rib 116.

As the conical end section 112 is turned and advanced toward the rib 116, the interior sloped walls 134 engage the outer surface 144 of the jaws and push the jaws closer to each other so that the gripping surfaces 150, 152 engage and secure the cable therebetween, as shown in Figure 7. When the end 128 of the conical end section 112 engages the central rib 116, the cable will be secured within the connector.

The second cable can then be inserted into the other end of the connector to be secured within the connector in a similar manner. It is not possible to use the tool hole 120 to secure the second cable within the connector because it has been covered by the opposite conical end section. Therefore, it is necessary to use the gripping surface to assist in turning the second conical end section 112.

The details of the jaws 140, 142, and their interaction with the cables, will now be described with reference to Figures 8 and 9. Figure 8 shows a center line "A" which extends through the middle of the electrical connector 110. The top jaw 140 has two gripping surfaces 150a, 152a. Each of the gripping surfaces 150a, 152a are parallel to the center line "A", the gripping surface 152a is further away from the center line "A" than the gripping surface 150a. The sloped surface is angled downwardly, as illustrated in Figure 8, from the gripping surface 150a to the gripping surface 152a. The second jaw 142 also has two gripping surfaces 150b, 152b, each of which are parallel to the center line "A". The gripping surface 152b is closer to the center line than the gripping surface 150b. the sloped surface 154 is angled downwardly, as is illustrated in Figure 8, from the gripping surface 152b to the gripping surface 150b.

The effect of having gripping surfaces at two levels is apparent from Figure 9. The cable C follows a

bent or curved pathway from the one set of jaws 152a, 152b to the second set of jaws 150a, 150b. The curvature of the pathway provides for a better grip on the cable to prevent pull outs. The forced bend in the cable provides for a better gripping force than if the gripping surfaces were in line with each other. The curvature of the pathway also provides for strain relief for the cable C.

Prior to termination of the cables, it is advantageous to place an antioxidant gel within the connector to provide a good electrical connection between the various components of the connector. To this end, the antioxidant gel can be inserted between the cooperating gels. The antioxidant gel can also be inserted between the outer surface 144 of the jaws and the interior wall 134 of the conical end sections 112. The antioxidant gel will prevent oxidation of the surfaces of the components so that during termination, good electrical connection will be obtained.

The advantages of the second embodiment of the present invention are that the connector can be terminate to one cable at a time. It is not necessary to terminated two cables simultaneously. Further, the connector can be filled with an antioxidant gel to provide a good connection between the components. Also, the connector can be assembled very easily using readily available tools.

What is claimed is:

1. An electrical connector (10, 110) for mechanically and electrically connecting two conductors together, the connector having a housing with a moveable  
5 jaw (14, 140), the jaw (14, 140) having two gripping surfaces (48, 50, 150a, 152a) for engaging the conductors, characterized in that one of the gripping surfaces (48, 150a) was disposed in a different plane than the other of the gripping surfaces (50, 152a)  
10 thereby defining a circuitous path for receiving the conductor therein.

2. The electrical connector of claim 1 wherein the plane of one gripping surfaces (48, 150a) is parallel to plane of the other gripping surface (50,  
15 152a).

3. The electrical connector of claim 1 wherein a complimentary jaw has third and fourth gripping surfaces (34, 36, 150b, 152b) which cooperates with the two gripping surfaces (48, 50, 150a, 152a).

20 4. The electrical connector of claim 4, wherein the electrical connector has a opening (22, 31) along each end of the housing, one of the conductors is received in each opening to provide an in-line connection from one conductor to the other conductor.

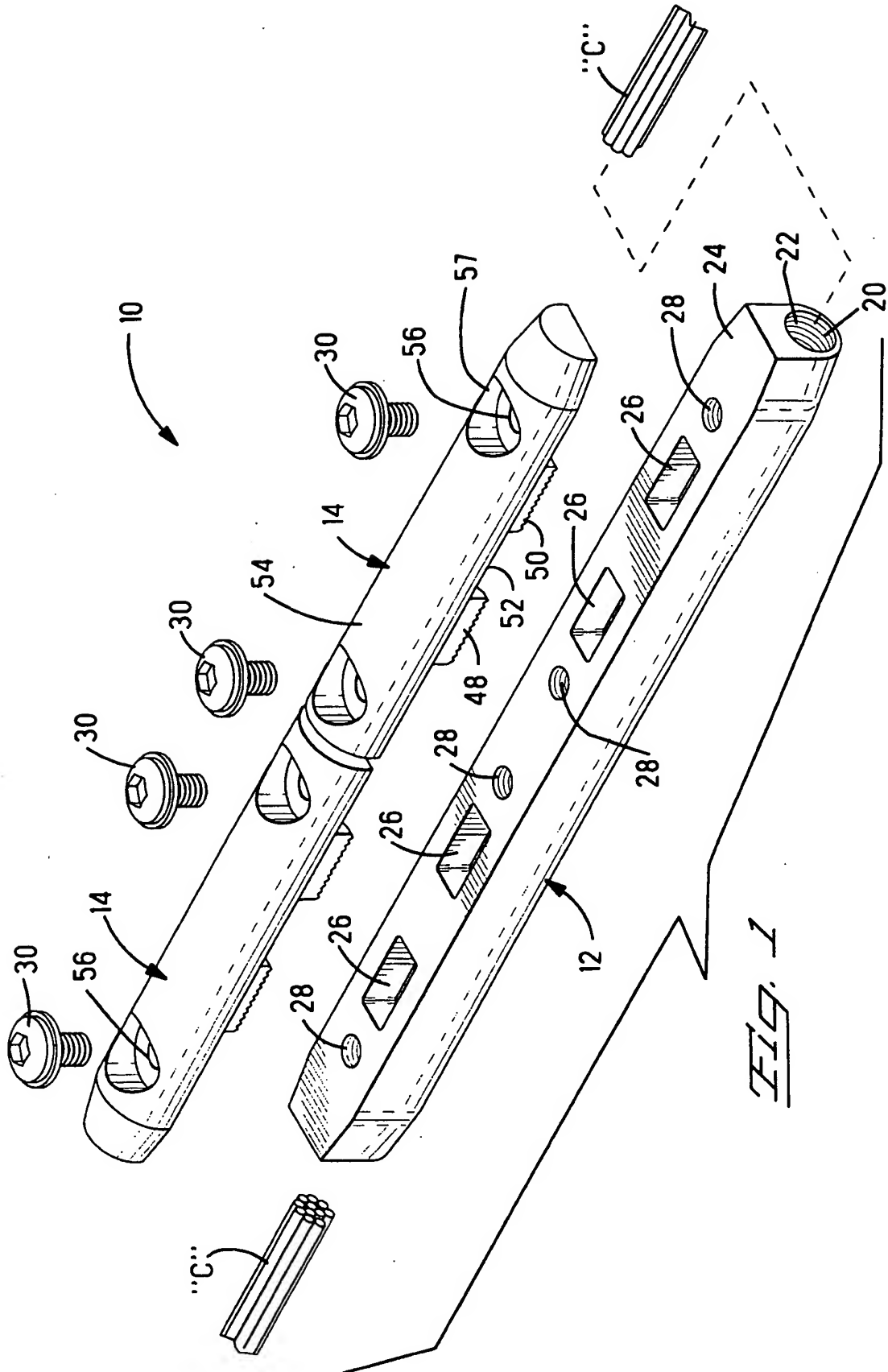
25 5. The electrical connector of claim 1 wherein the housing has a central member (114) having a first securing portion (118), the jaw (140) extends from the central member (114), and a conical member (112) having a hollow interior and a second securing portion (136),  
30 the second securing portion (136) engages the first securing portion (118) and the jaw (140) being received within the hollow interior whereby as the securing portions (118, 136) are tightened together the jaws (140) are pushed together in order to grip the conductor  
35 therebetween.

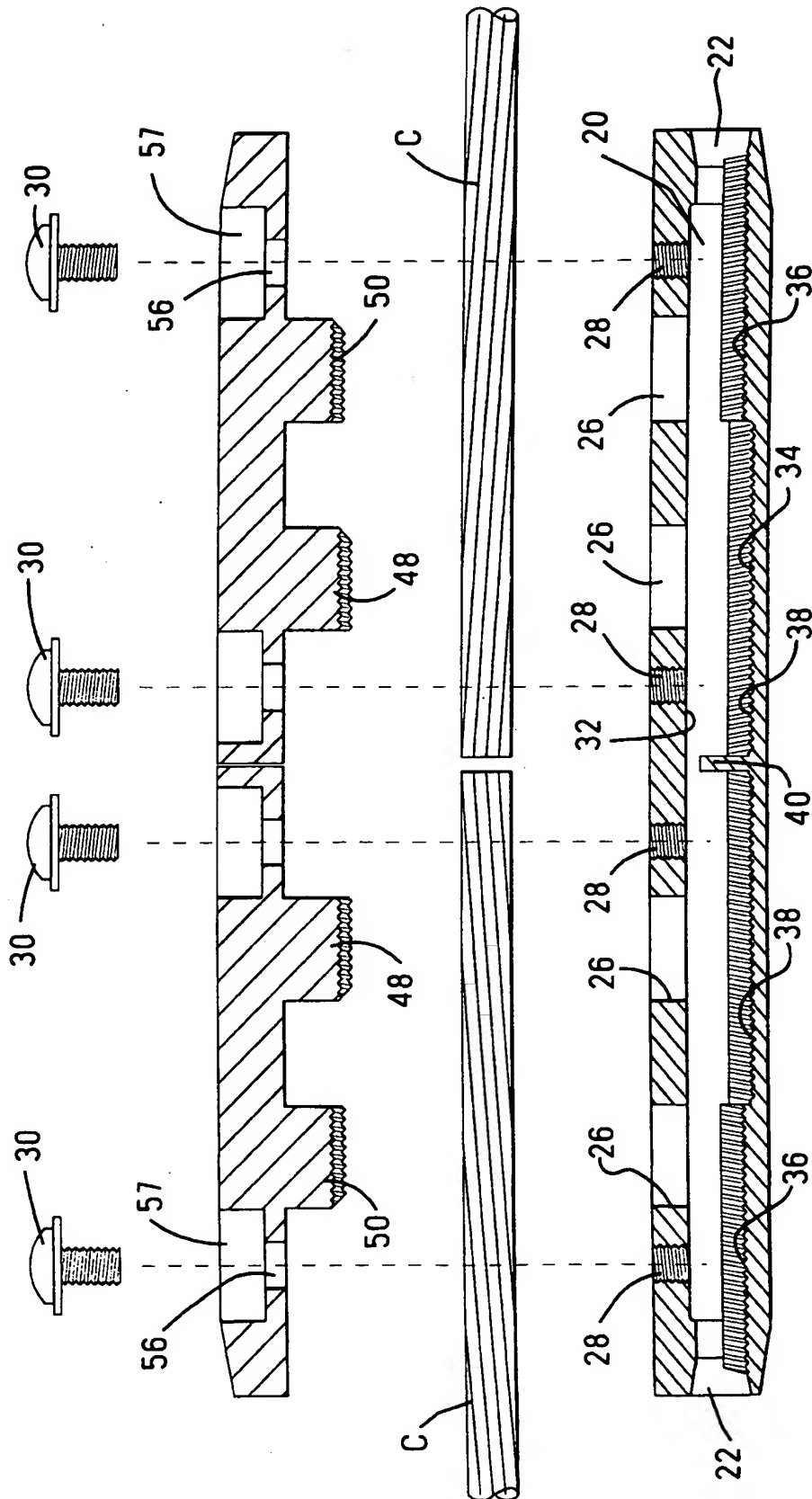
6. The electrical connector of claim 5, wherein the first and second securing portions (118, 136) are first and second threaded portions.

5 7. The electrical connector of claim 1, wherein the housing has two ends (20) with the conductor receiving passage extending therebetween, there being a separating wall (40) disposed within the passageway to separate the passage into two chambers for receiving two of the conductors.

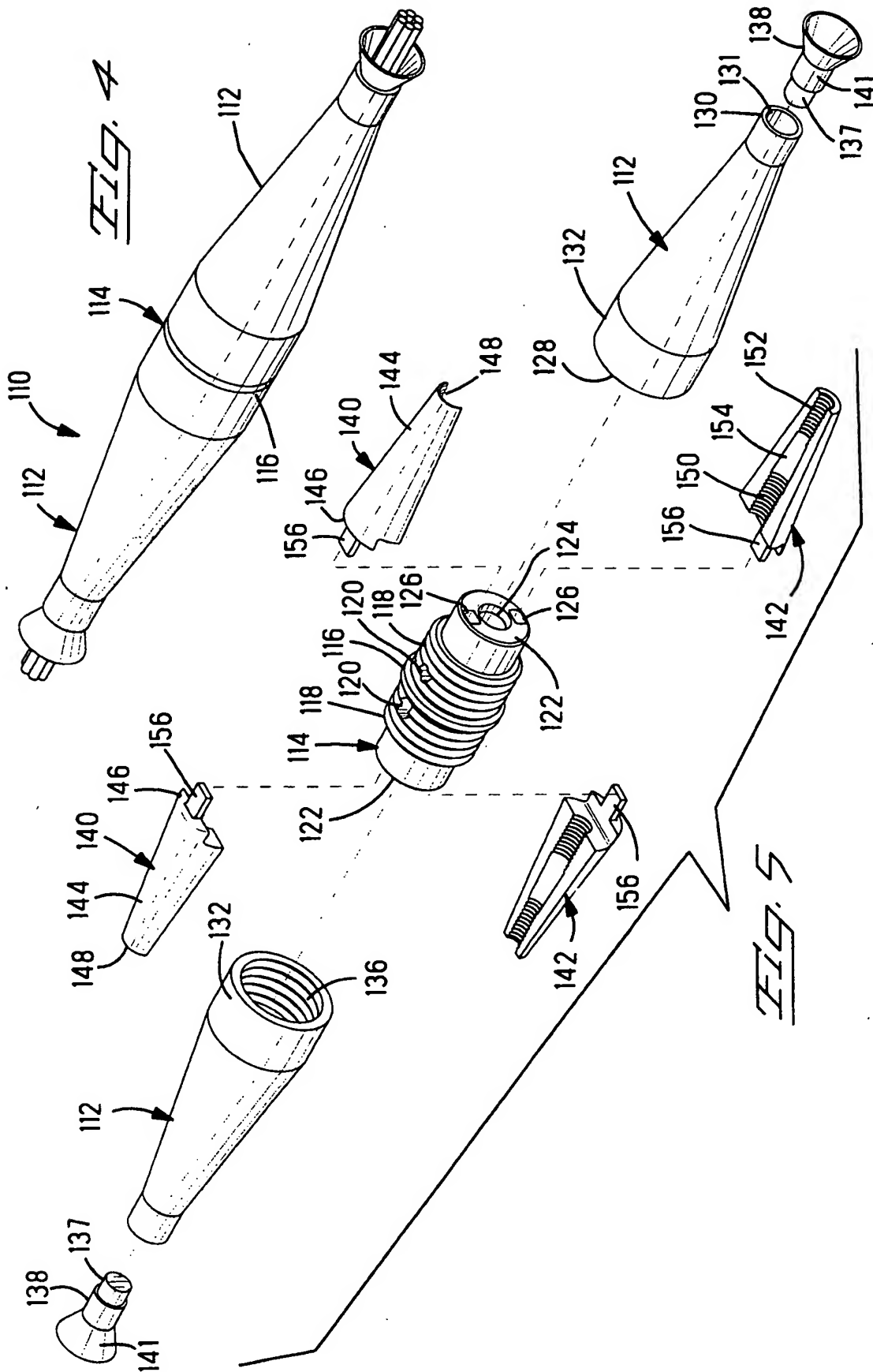
10 8. The electrical of claims 7, wherein the jaw (14) is secured to the housing by a screw (30) and the jaw (14) is moved into and out of engagement with the conductor by actuating the screw (30).

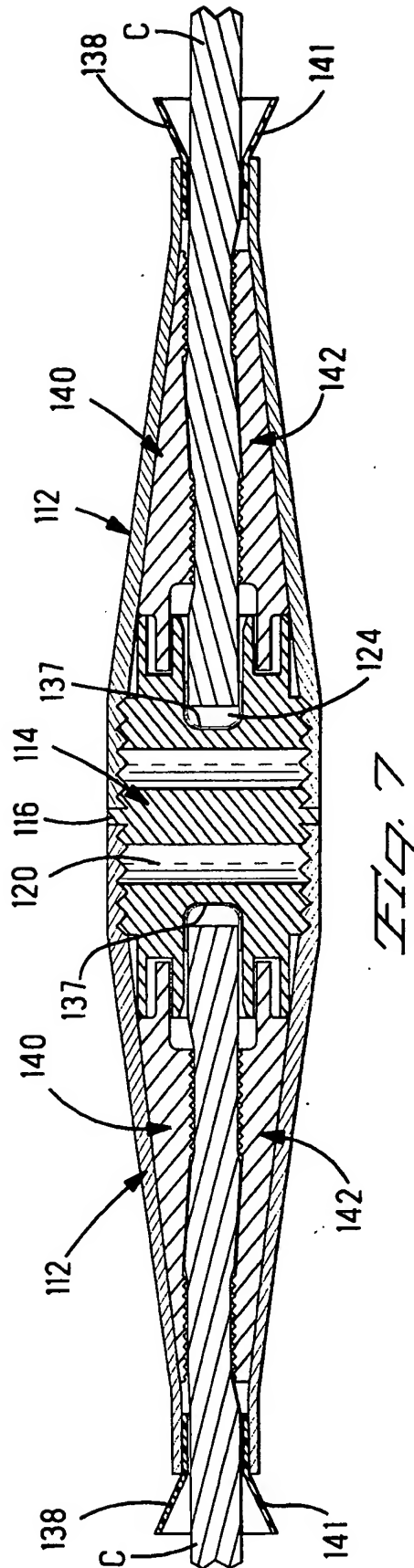
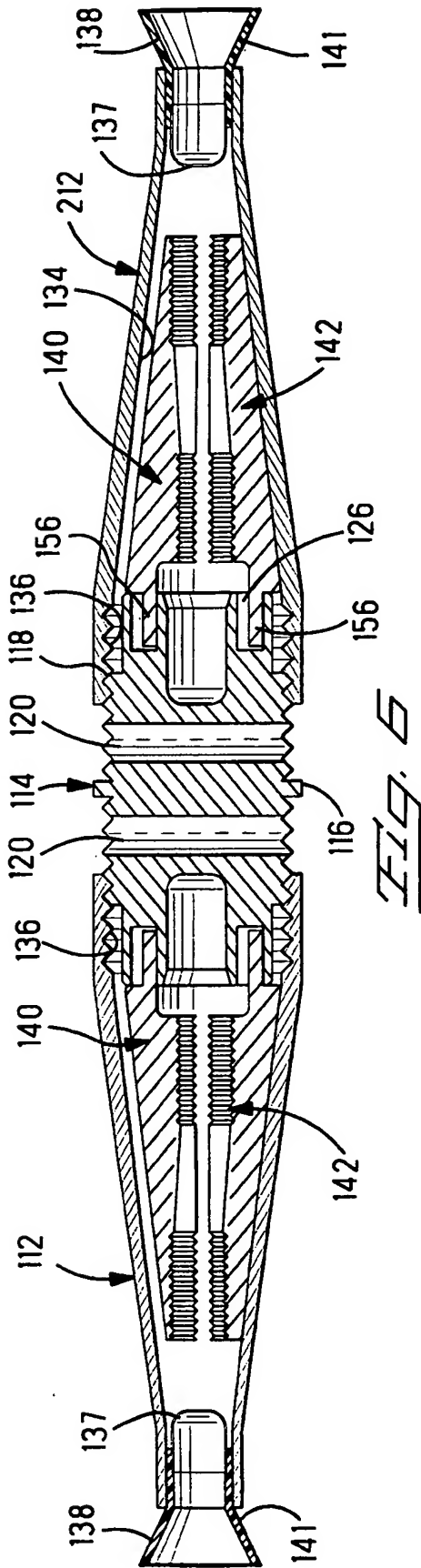


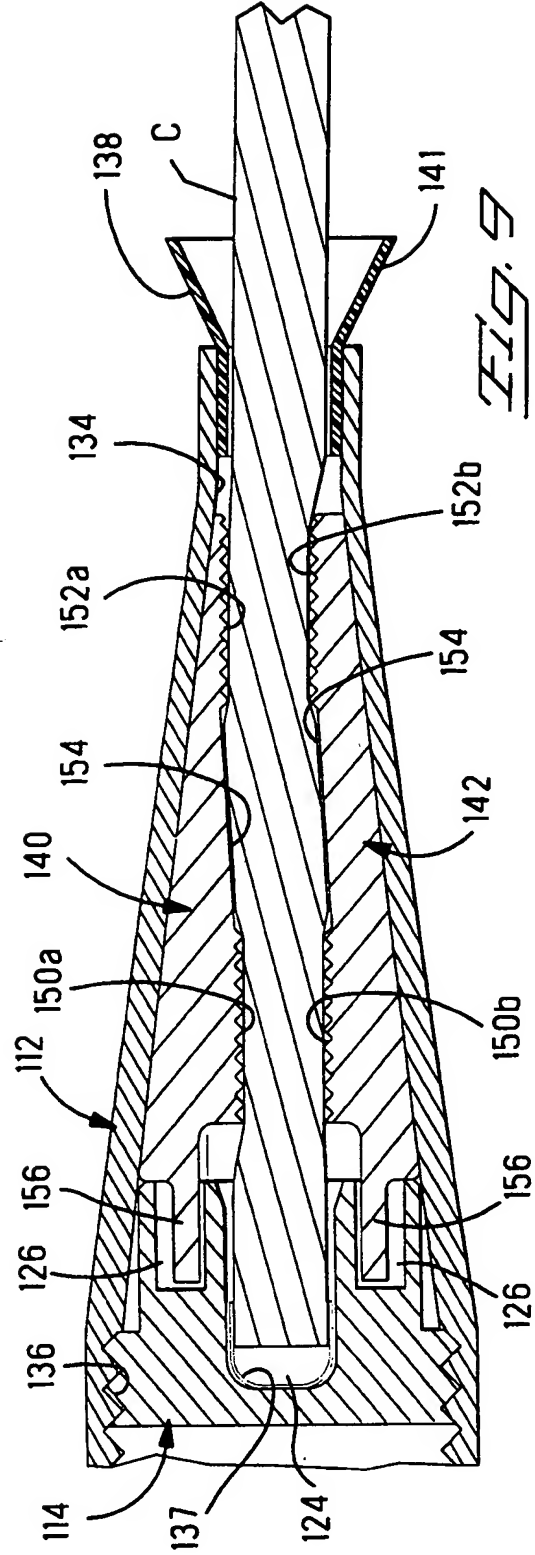
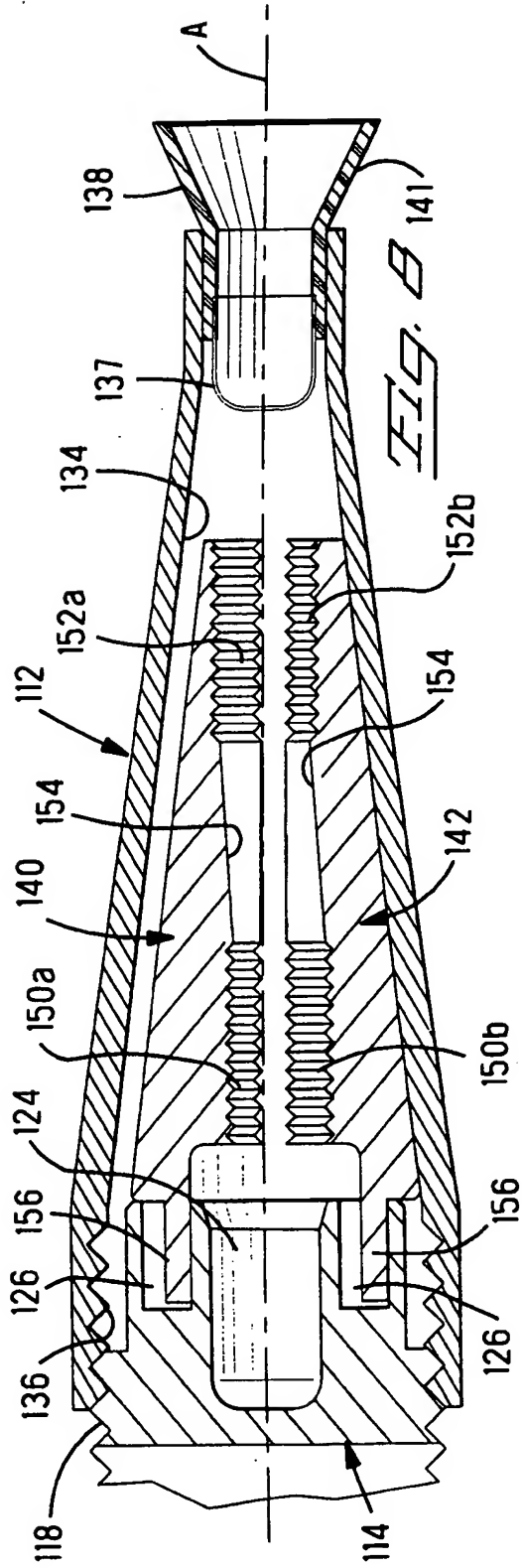


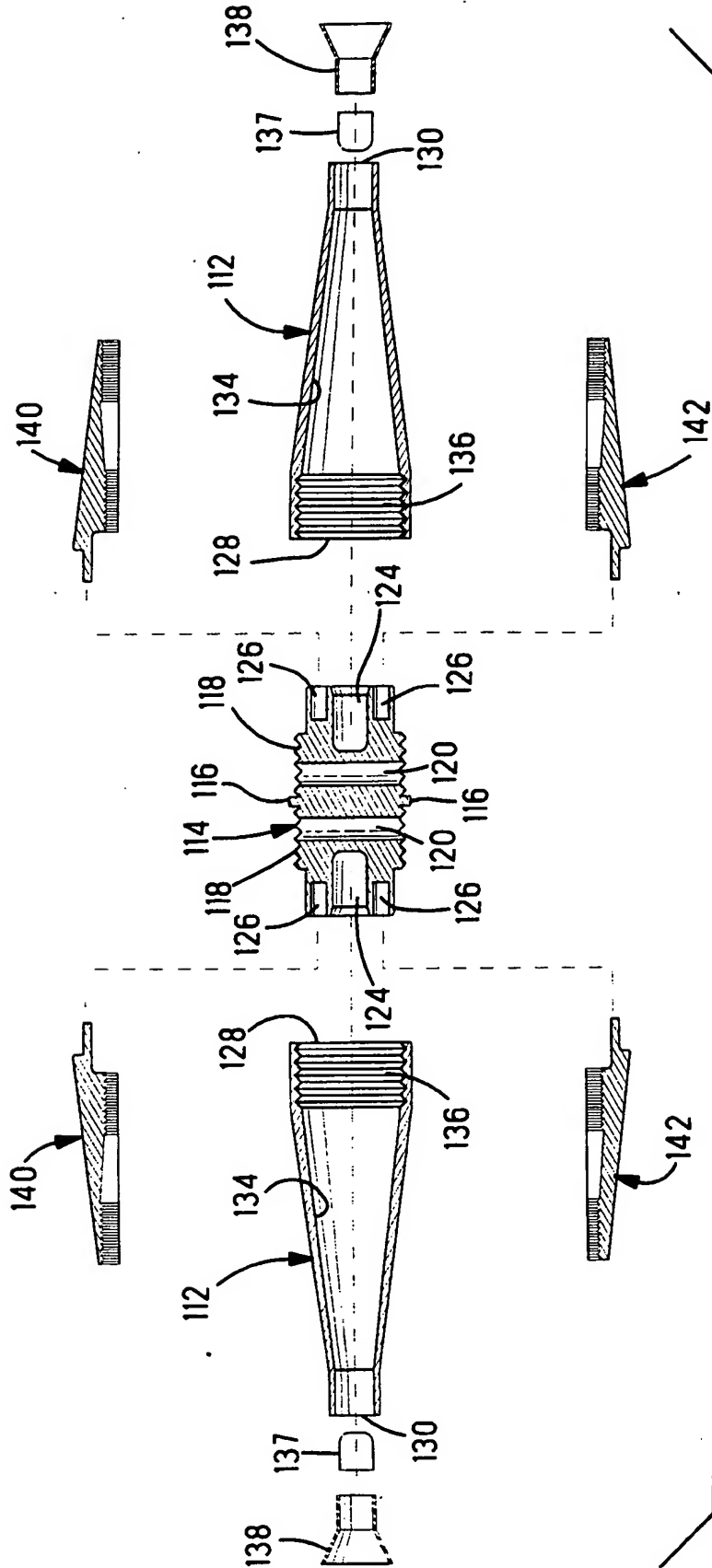
FIG. 2











<b>A. CLASSIFICATION OF SUBJECT MATTER</b> IPC 6    H01R4/50    H01R4/44				
According to International Patent Classification(IPC) or to both national classification and IPC				
<b>B. FIELDS SEARCHED</b> Minimum documentation searched (classification system followed by classification symbols) IPC 6    H01R				
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched				
Electronic data base consulted during the international search (name of data base and, where practical, search terms used)				
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>				
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.		
Y	US 4 752 252 A (CHERRY HITESH ET AL) 21 June 1988 see the whole document see figures 2,3	1,3-7		
Y	US 2 187 230 A (L.FRANK) 16 January 1940 see page 2, line 63 - line 75 see figures 4,8	1,3-7		
E	US 5 683 273 A (GARVER WILLIAM JOSEPH ET AL) see the whole document see figures 1-7	1-7		
A	FR 1 025 428 A (L. FERRAZ) 21 April 1953 see page 1, column 1, line 34 - column 2, line 8 see figure 4	1,8		
-/--				
<input checked="" type="checkbox"/> Further documents are listed in the continuation of box C. <input checked="" type="checkbox"/> Patent family members are listed in annex.				
* Special categories of cited documents :				
<table style="width: 100%; border: none;"> <tr> <td style="width: 50%; vertical-align: top; padding: 5px;">           "A" document defining the general state of the art which is not considered to be of particular relevance            "E" earlier document but published on or after the international filing date            "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)            "O" document referring to an oral disclosure, use, exhibition or other means            "P" document published prior to the international filing date but later than the priority date claimed         </td> <td style="width: 50%; vertical-align: top; padding: 5px;">           "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention            "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone            "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.            "&amp;" document member of the same patent family         </td> </tr> </table>			"A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. "&" document member of the same patent family
"A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. "&" document member of the same patent family			
Date of the actual completion of the international search	Date of mailing of the international search report			
6 February 1998	26/02/1998			
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Authorized officer  Aivazian, D			



C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 362 352 A (HAWKINS RONALD G ET AL) 7 December 1982 see column 1, line 50 - column 3, line 7 see figure 1 -----	5

1

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4752252 A	21-06-88	NONE	
US 2187230 A	16-01-40	NONE	
US 5683273 A	04-11-97	NONE	
FR 1025428 A	21-04-53	NONE	
US 4362352 A	07-12-82	NONE	